

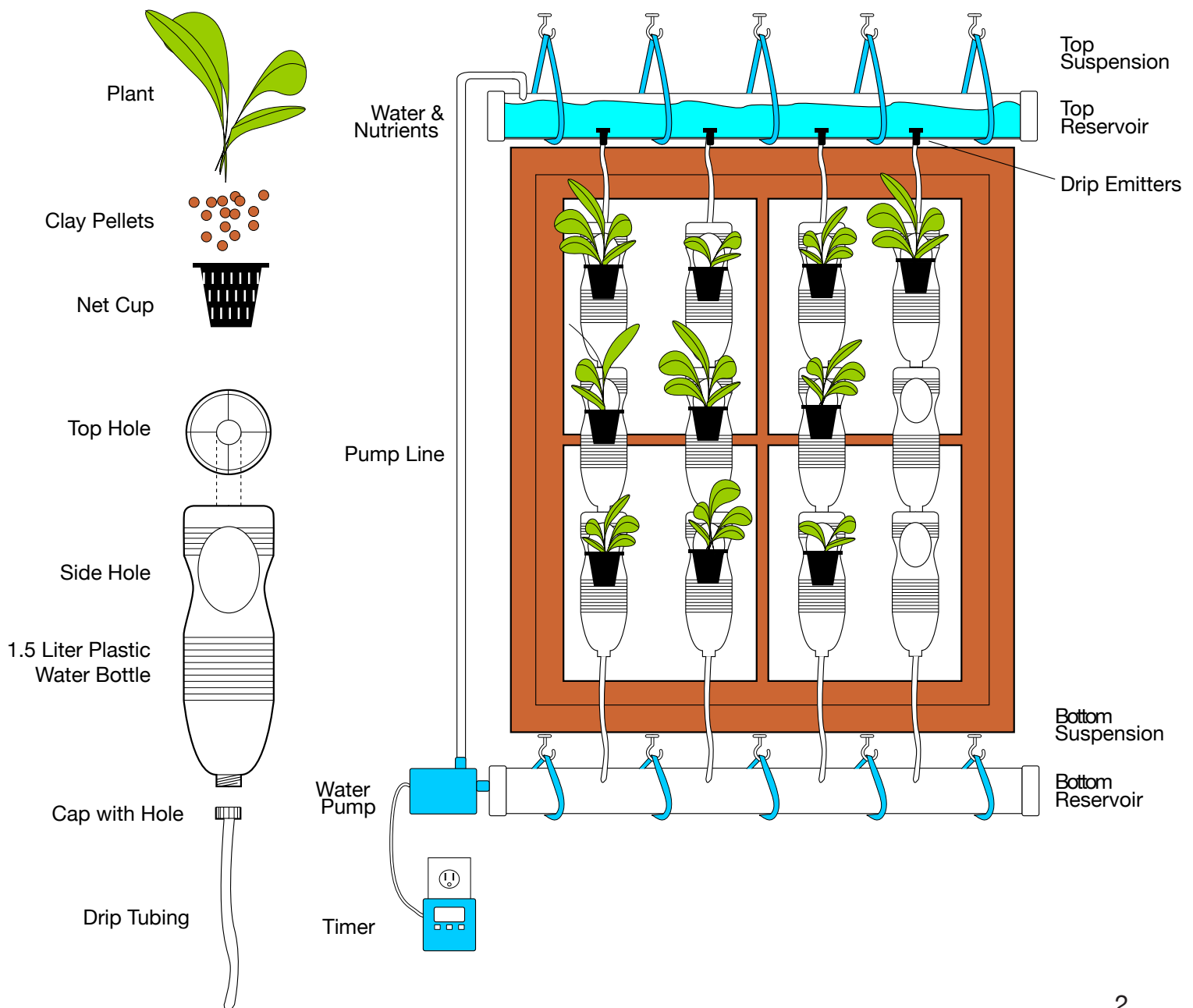


how to build your own window farm

windowfarms.org
our.windowfarms.org

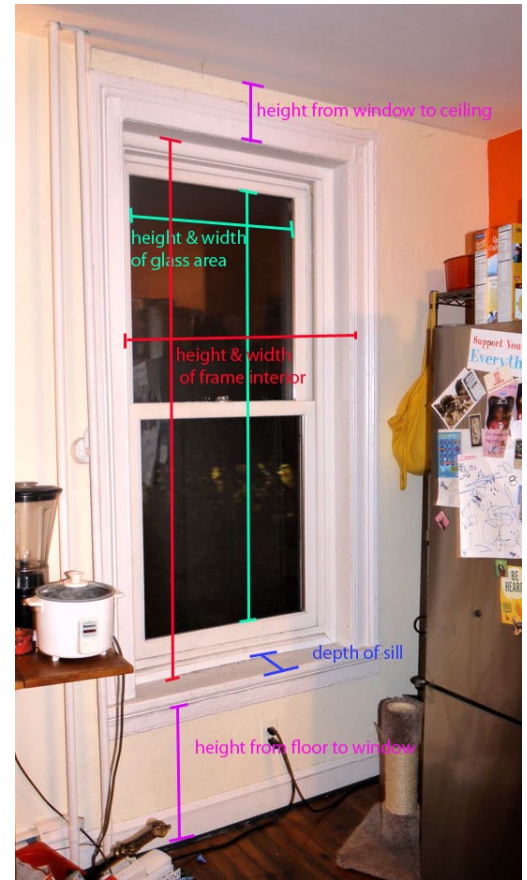
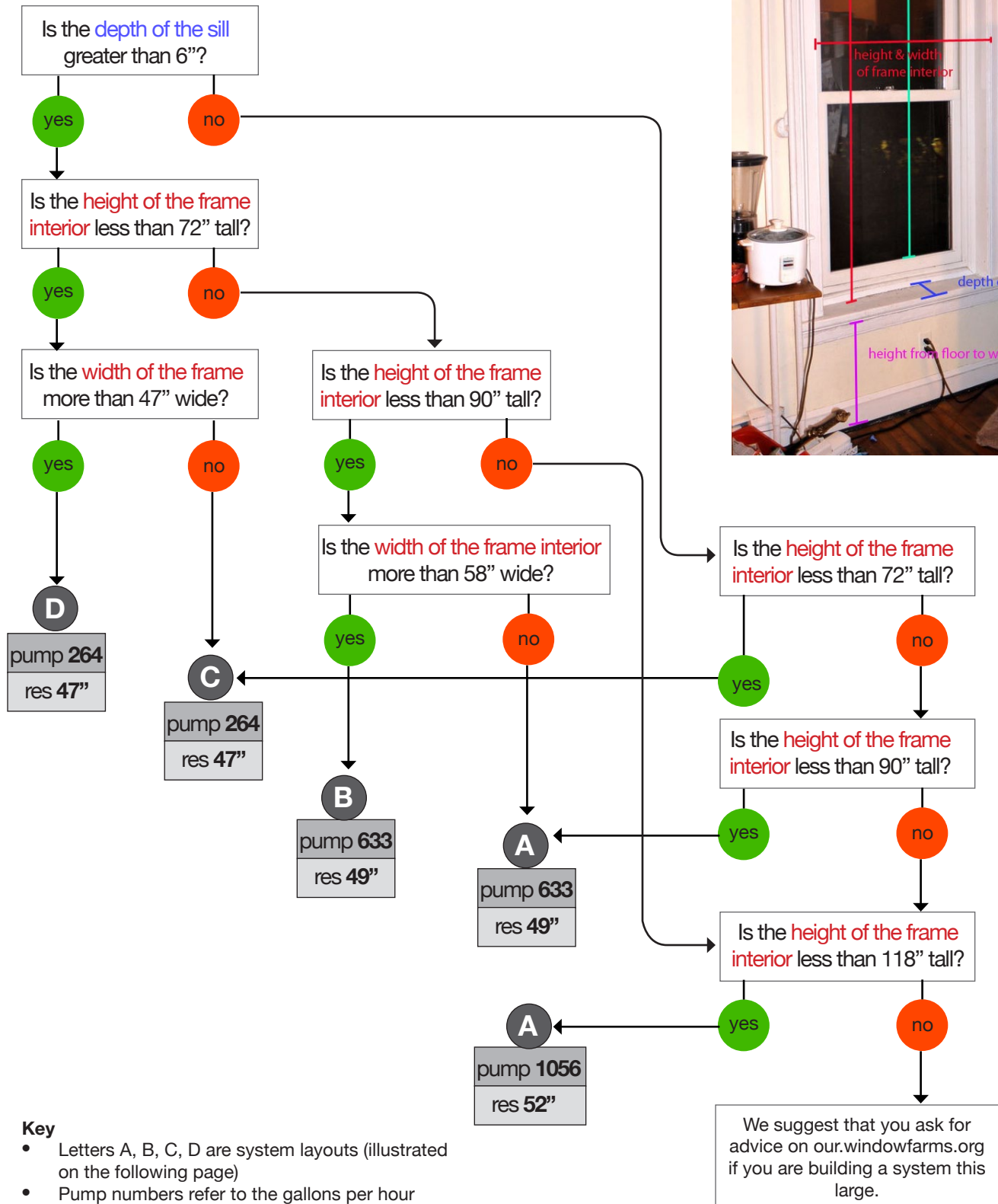
1) About This Window Farm

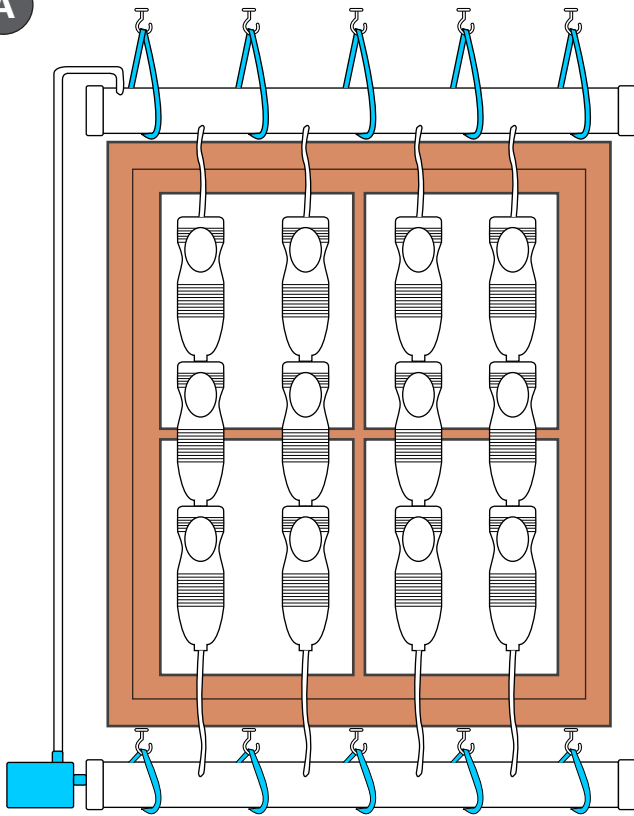
The window farm described in this How-To is a reservoir system. A water pump on a timer periodically pumps water and liquid nutrients from the bottom reservoir to the top reservoir. There are small holes drilled into the underside of the top reservoir. Small drip emitters with valves let out a constant drip of water and nutrients into a column of plants. Each plant sits in a grow medium in a net cup (a perforated plastic cup commonly used in hydroponics), within an inverted plastic water bottle. The cap of each water bottle has a hole in it so that the water and nutrients can drip from one bottle to the next, from the top to the bottom of the column of plants. The bottom-most bottles are connected to tubing that takes the water and nutrients into the bottom reservoir, where it sits until the pump turns on again.



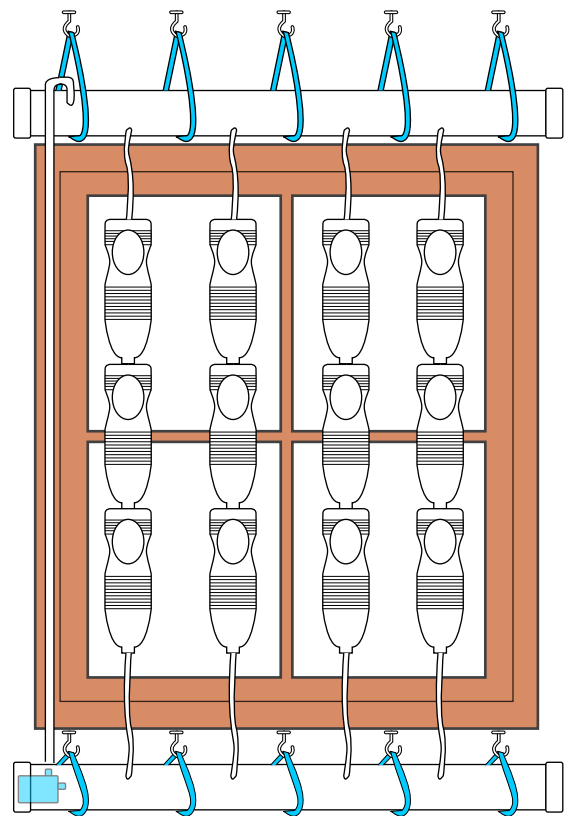
2) Measure the Size of Your Window

The type of window you have, and the architecture of the space around it, will determine quite a bit about your system. Follow the chart below to find your system type. Use the photograph to the right as a reference for the types of measurements. Circle your system letter (A, B, C or D), Pump and Res #s.

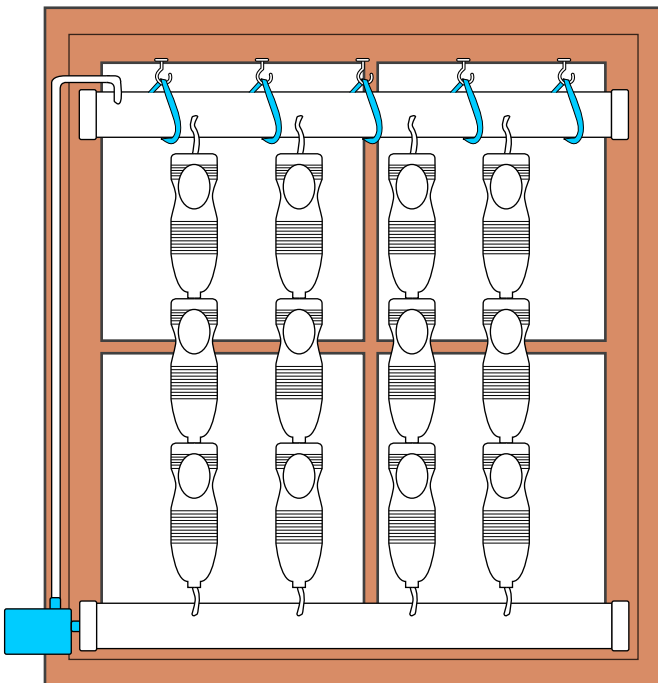


A

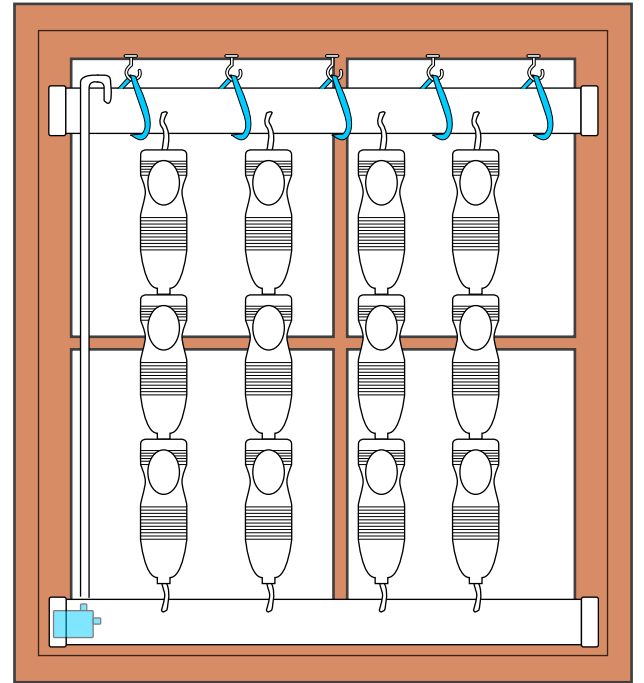
System A: The top reservoir is above the window. It can be suspended from the wall or ceiling. The bottom reservoir is suspended from the window frame or just beneath it. The pump housing is outside of the bottom reservoir.

C

System C: The top reservoir is above the window. It can be suspended from the wall or ceiling. The bottom reservoir is suspended from the window frame or just beneath it. The pump housing is inside the bottom reservoir.

B

System B: All of the components are within the window frame. The pump housing is outside of the bottom reservoir.

D

System D: All of the components are within the window frame. The pump housing is outside of the bottom reservoir.

3) Measure the Size of Your Glass

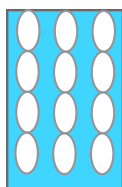
a. Window Glass Size: Measure your window - the glass area itself, not including the window frame. On the chart on the right, find the column that corresponds with the width of your window glass area and the row that corresponds with the height. In the chart, **circle the maximum plants and columns** for the width and height of your glass area.

b. Determine the number of plants and layout: In the blue column in the chart you will find the maximum number of plants your window can hold, and the white column shows the maximum number of columns of plants. Divide the number of plants by the number of columns to figure out the maximum number of plants that will be in each column. Write the number of plants and columns you will have in your system here:

PLANTS: _____ COLUMNS: _____

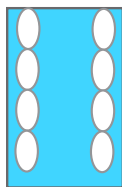
		glass area width													
		< 14"		14"-24"		24"-36"		36"-48"		48"-60"		60"-72"		72"-84"	
glass area		max # of plants	max # of columns												
	< 14"	1	1	2	2	3	3	4	4	5	5	6	6	7	7
	14"-24"	1	1	2	2	3	3	4	4	5	5	6	6	7	7
	24"-36"	2	1	4	2	6	3	8	4	10	5	12	6	14	7
	36"-48"	3	1	6	2	9	3	12	4	15	5	18	6	21	7
	48"-60"	4	1	8	2	12	3	16	4	20	5	24	6	28	7
	60"-72"	5	1	10	2	15	3	20	4	25	5	30	6	35	7
	72"-84"	6	1	12	2	18	3	24	4	30	5	36	6	42	7

Simply remember that the plant containers are 12" high, and each plant needs about a 12" width of growing space to itself. However, if you are growing large plants such as tomatoes, you will need to give them at least 24" of growing space. For example, if your window glass area is 36" wide x 52" tall, the chart specifies 12 plants in 3 columns, you would sketch this

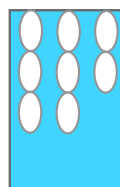


You can choose to modify this to have, for example:

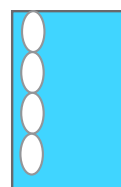
8 plants in 2 columns



8 plants in 3 columns

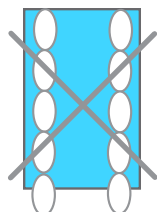


4 plants in 1 column

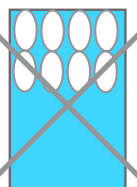


But you *cannot* have:

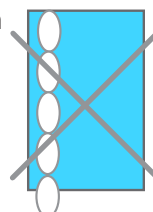
10 plants in 2 columns



8 plants in 4 columns



5 plants in 1 column



4) Layout Your System

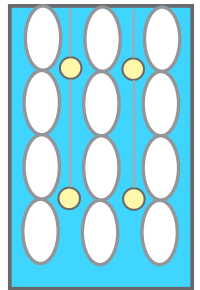
a. Sketch your window: Use the next page to help layout your system.

b. Draw in the bottom and top reservoirs as shown in your system layout on page 2. If your system includes a pump outside the reservoir, draw that as well. Keep in mind the minimum length of your reservoir (47", 49" or 72") that you circled 2 pages ago, in the light gray box. Your reservoirs can be longer in inches than that number, but they should be the same length as each other. When you have determined how long your reservoirs will be, write the number here:

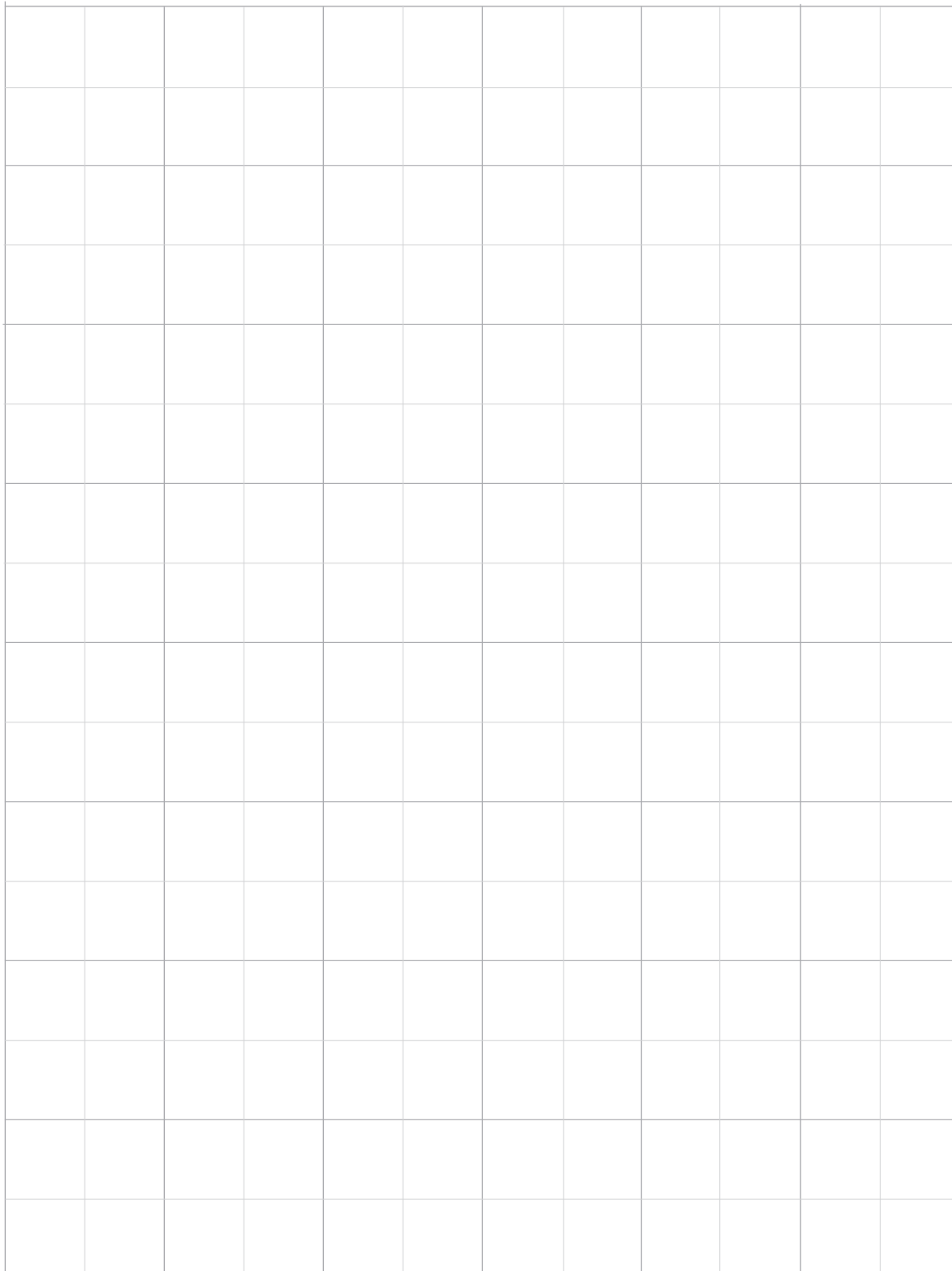
LENGTH OF RESERVOIRS: _____

c. Add the plant containers, as described on the previous page. You can choose how far from the top of the window the first bottle in a column will start. **Add plants to the sketch.** If you have not already, decide what type of plants you would like to grow and draw them in at the size they will be at their largest. In this system, the plants emerge from the top 6 inches of the bottle.

d. Add lights to your sketch. If your window gets no direct sunlight or less than 14 hours of direct or indirect light a day, you will need to supplement the natural light with light bulbs. The number and placement of lights will be determined by the type, size and number of plants you are growing. We recommend CFL bulbs that are 100-watt equivalent in the daylight spectrum (available at a hardware store). You can look at our.windowfarms.org for more information about how many lights you should have, but a general rule of thumb is 1 bulb within 2 feet of each plant. You will want to make sure that the plants do not touch the bulbs, however, so do not place them too close, or consider rigging up a clear protective shade around the bulbs. The layout at the right would be a good configuration for a window that gets some indirect light.



4) Layout Your System



If you sketch the system on the grid so that one square = 1 foot,

1 sq. ft.

the water bottles should be this size:

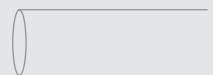
12" from bottom to bottle cap, but because they are nested, figure 11" for each bottle.



a typical lettuce plant would be this big full grown:



the reservoirs would be this tall:



and the lights would be about this big:



5) Determine what materials you will need

See the next to last page of this document for information on where to buy these materials.

Item	Amount	Specs
Plants	Your # of plants:	See step 27
Water bottles	Your # of plants:	1.5 liter ecoshape bottles
Net cups	Your # of plants:	3" net pots from hydroponic retailer
Plastic martini glasses	Your # of columns:	See Step 7 for a photo or here for an image: http://images.buycostumes.com/mgen/merchandise/28026.jpg
Cuphooks	Your # of columns:	
Drip valves	Your # of columns:	Ask at an pet or aquarium store for an 'air control kit' or two way valves for aquarium air control like these: http://www.aquariumguys.com/twowayvalve.html .
3/8" OD - 1/4" ID tubing	See step 17. The amount will be (your # of columns) x (the distance between the end of your bottom bottle and the reservoir).	3/8" OD, 1/4" ID clear or black tubing (clear will need to be cleaned)
1/4" OD tubing	See step 16. The amount will be (your # of columns) x (the distance between the top reservoir and the net cup in the top bottles).	1/4" OD, 1/8" ID clear or black opaque tubing (clear will need to be cleaned)
1/2" ID rigid opaque tubing	The length of tubing will depend upon how far apart your reservoirs are. The tubing must go from the pump to the top reservoir. Buy at least 3 feet more than that to be safe.	1/2" ID rigid opaque tubing: Home Harvest Part number #TUB12HF at http://homeharvest.com/dripirrigationtubing.htm
Pump	1 and optional pump filter bag to prevent clogging: http://www.horticulturesource.com/ecoplus-pump-filter-bag-10-x-12-5-large-size--p1049/	The pump number you circled on page 1 indicates the gallons per hour that the pump should pump.
Pipe for reservoirs	2 x length of reservoir length you wrote on page 2. In other words, if you need 48" reservoirs, you will need at least 96" of pipe to cut into 2 48" pieces.	4" diameter sewer pipe, with 1/8" thick walls. Usually comes in 10' lengths.
End caps for pipe	4	4 Fernco rubber quickconnect endcaps with o-clamps to fit the 4" diameter pipe. Found in plumbing area of hardware store.
Pump timer	1	Digital timer with 8 on-off switches per day
Suspension cable and heavy duty hooks	At least 8 feet of cable.	Cable, rope, chain, or strap for suspending reservoirs and hooks that will hold at least 50 lbs. Ask at your hardware store for the best hooks for your wall type.
Extension cord		With multisocket
Light sockets & plugs	Depends on the number of lights in your system	Light sockets with plugs or Lamp wire, Pigtails and Sockets - See step 21
Light timer	1	Regular appliance timer
Bulbs	Depends on the number of lights in your system	100-watt equivalent CFL in Daylight spectrum
Tape		Duct tape or gaffer's tape
Bottle covers	Your # of plants:	See step 9
Suspension wire	At least 8 feet	Fishing wire, flexible cable (and clamps), or string for suspending bottles
Cleaning brushes		Pipe cleaners, bottle brush, and a new toilet brush that will fit inside pipes for periodic cleaning
Cord suspenders	2 for each light cord	For hanging lights
Clay pellets	3 handfuls per plant	
Air pump	1	Air pump and airstone from aquarium store
Nutrient solution		

Tools

- | | |
|---|---|
| <input type="checkbox"/> 1" flat/spade drill bit | <input type="checkbox"/> Drill bits: various sizes including 1/4", 3/8", 1/2", 1" |
| <input type="checkbox"/> Sharp box cutter or X-acto knife | <input type="checkbox"/> Large funnel to refill water and nutrients |
| <input type="checkbox"/> Paper hole punch | <input type="checkbox"/> Measuring spoons (for the nutrient solution) |
| <input type="checkbox"/> Drill | <input type="checkbox"/> Hack saw to cut through reservoir |

6) Construction & Assembly

Bottles

Step 1- Drill hole in bottom center of each bottle using a 1" flat/spade bit.



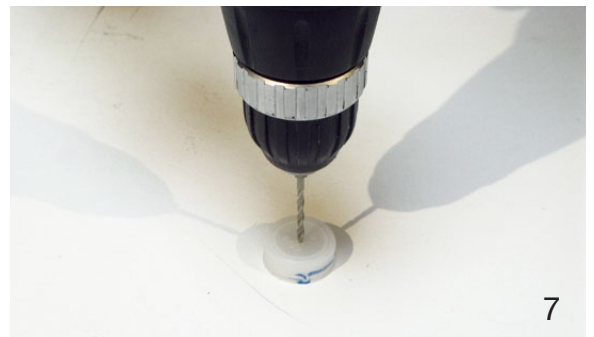
Step 2- Cut out one trapezoidal area in the side of the bottom of the bottle large enough for the net cup to fit through.



Step 3- Punch two holes directly opposite one another close to the bottom of the bottle by inserting a paper hole punch through the newly cut-out trapezoidal area. Make sure the placement is the same for all your bottles.



Step 4- Drill a 3/8-1/2" hole in the center of each bottle cap.



Step 5- Cut the very bottom out of the end of one plastic martini glass stem for each column you have. If you have 4 columns, prep 4 martini glasses. Use a very sharp box cutter or x-acto to circle the base, go slowly, and be careful not to shatter the end.



Step 6- Pick one bottle to be the bottom of each column. Cut off the top of each of these bottles about 1 inch below the beginning of the mouth.



Step 7- Use a thin strip clear duct tape or gaffer's tape to tape the rim of the martini glass all the way around the top of the bottle on the outside. You may have to cut the top back to create a better fit, but do not cut too much off. The purpose is to create a solid funnel shape that connects to tubing at the bottom so water can flow through the bottle, to the martini glass stem, and into tubing.

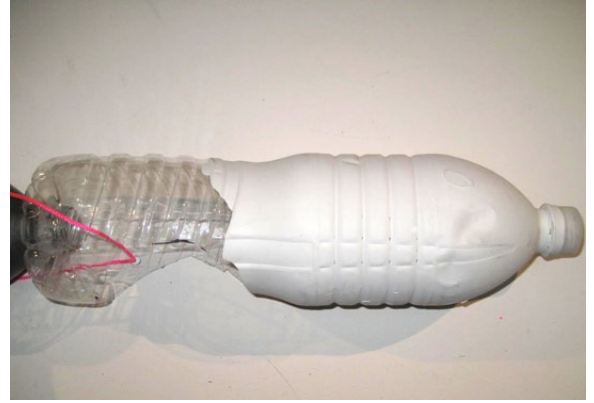


Step 8- Attach 6 inch strips of 3/8 inch (outside diameter) tubing over the very ends of the martini glasses. It helps to pour some boiling water into a cup and dip the end of the tubing into the hot water for a few seconds to make it pliable before shoving it over the end. It does not need to go all the way on, just about 1/2 inch, to the ridge at the base.



Step 9- Make the entire top portion of each bottle opaque (including the martini glass addition, if it has one) so that the roots are not exposed to light. Cover the entire “waist” portion of the ecoshape bottle. Choose one of these methods or invent your own:

a) Spray paint- create a stencil and spray paint.



b) Paint Dip- dip the ends in paint. Kilz Latex Primer seems to work well. This can be tricky.



c) Balloon- Get some 26” balloons. Cut out a circle at the very top of the balloon. Stretch the balloon over the top of the bottle. Use a thin strip of duct tape to secure it up high if necessary. Silver looks nice.



Other ideas not pictured:

d) Collage- Glue scraps of something over the whole area.

e) Tape- Cut out and attach slices of tape.

Step 10- Make your columns. Screw each bottle top into the end of the one below it. Screw on the one with the martini glass last. Turn the whole thing upside down. That's your column.



Suspension

Step 11- For the Column Suspension, place cuphooks (each column of bottles will hang from one) at evenly spaced intervals across the width of the window's glass area. You can screw them into the window frame's ceiling, into the wall above the window, or into the ceiling above the window. If you choose the window's ceiling, place them close to the interior edge of the window, rather than close to the glass so there's at least 6-8" left between the glass and the plants for CFL bulbs if your plants end up needing additional light. Optimally, there should be 8-24" between each column widthwise, depending upon how large your plants get.



Step 11 - ALTERNATE METHOD- Skip the cuphooks. Loop the strands around the top and bottom reservoirs in such a way that they can be removed. Use two supporting strands and clamp the bottles to the strands using alligator clips with a 1/8 wooden dowel between.



Step 12- Hang the columns of bottles from the cuphooks with loops of fishing wire, flexible cable, rope or string. For each bottle, run a loop through the little holes, going all the way up to the cuphook at the top of that column. For a cleaner look, use monofilament crimp beads instead of tying. Later, it may be helpful to be able to lift a single bottle with it's loop off the cuphook for cleaning. . If the loops have a tendency to get messy, you can tie them all together through the holes in the top bottle.

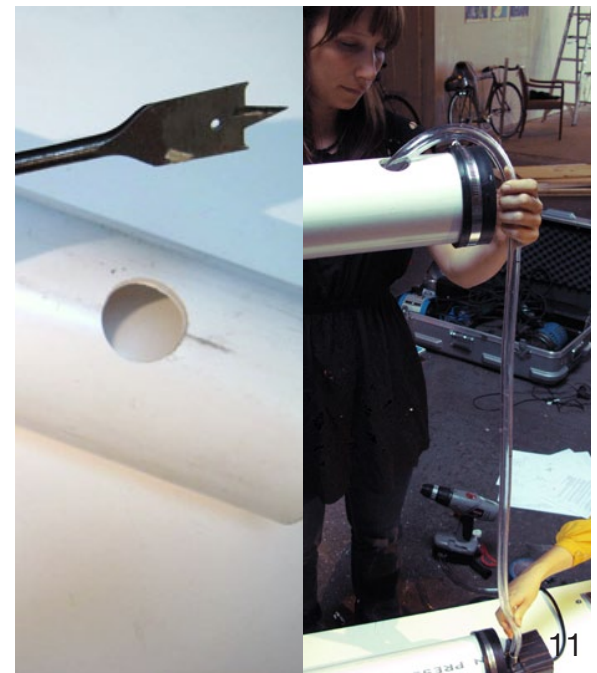


Reservoirs

Step 13- To assemble the reservoir, cut the top and bottom reservoir pipes to the proper width you calculated at the beginning. Add both endcaps to the top reservoir and one endcap to the bottom. Screw down their clamps. Screw down their clamps.



Step 14- Determine on which side of the window you will put the pump and decide which is the top vs. bottom reservoir. Drill a 1" hole through the top reservoir pipe with the 1" flat/spade bit. Put this hole at least 4" in on what will be the pump side of the window. For the top reservoir, this is where the tube coming from the pipe below will enter the top reservoir. Drill another 1" hole in the bottom reservoir on the side opposite the pump, this is where you will fill it and where the aerator will go. Then, for each column, drill a 1/2" hole in the bottom reservoir so that it will be below the center of the column above it (directly below the cuphooks you placed up top!). Make sure to drill these holes on the same side of the pipe as the larger 1" hole you have already drilled (the top of the pipe). You will insert the tubing coming out of the bottom rows of bottles into these smaller holes. You may need to clean plastic scraps out of the tube before you fill the pipe to prevent clogging.



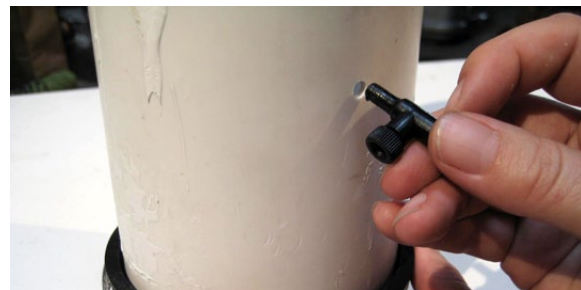
Step 15- Determine which of the following options best suits the size of pump you chose.

a) ECO PLUS 264- If you have the ECO PLUS 264 model, it fits inside the bottom reservoir, so all you have to do is cut another hole in the top of the bottom reservoir for the tube to come out. This obviously needs to be on the pump side. Continue to step 16.

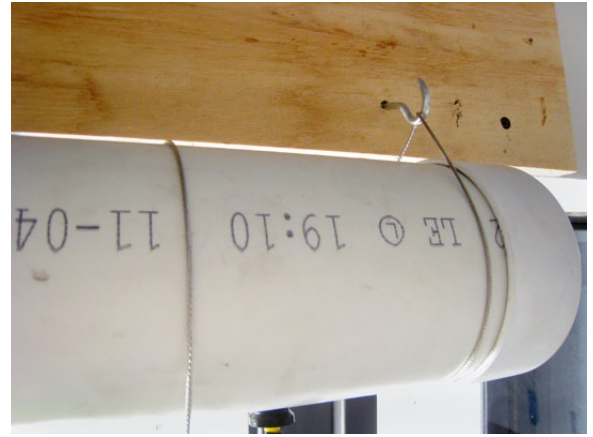
b) ECOPLUS 633 or another pump that's too large to fit inside the bottom reservoir- Drill a hole slightly smaller (two sizes smaller) than the outside diameter of the intake for your pump. as close as possible to the bottom of one of the endcaps. Remove the casing, the filter and the intake cover from the pump so that the intake shaft is fully exposed. Insert the pump intake into the hole. Then replace the intake cover and the filter, sandwiching the endcap between them and the pump. Place this endcap on one side of your pipe and screw down its clamp. The filter and pump intake are now inside the pipe that will be your bottom reservoir.



Step 16- Drill 1/4" holes for drippers in the underside of the top reservoir. Each one should be properly centered width-wise over a column of bottles. Attach the plastic adjustable valves on the underside of the top reservoir. Cut a piece of the smallest (1/4") tubing so that it reaches the net cup in the top bottle of the column.



Step 17- Suspend the pipe reservoirs above and below the window, respectively, using cuphooks and two loops of cable, rope, or strap as shown.



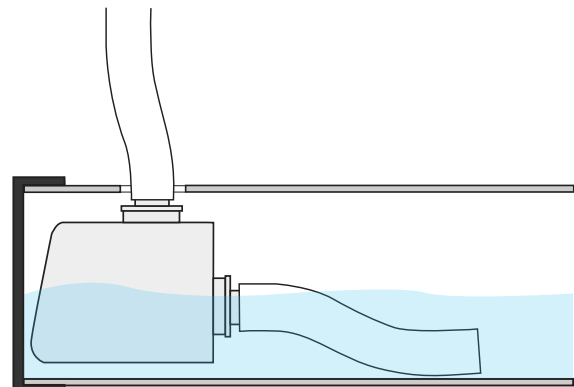
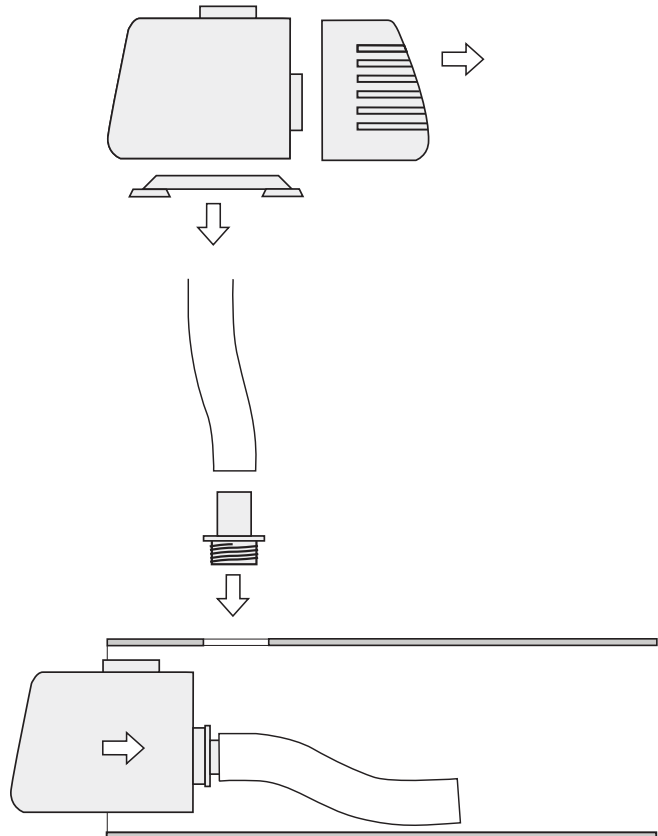
Step 18- Step 18: Place pump inside of bottom reservoir

To insert the pump into the bottom reservoir make sure that snap on base and the intake cover have been removed.

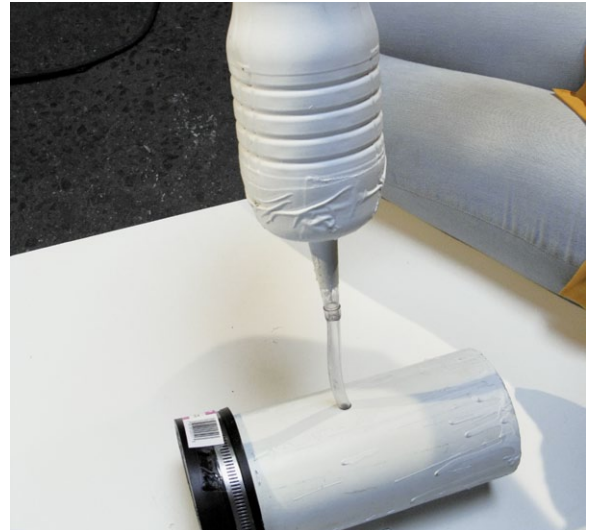
Drill another one inch hole on the top of the reservoir for the tube that lifts the water to the top of the window farm. This hole should be 1" in diameter, and 4" from the end of the pipe.

Attach the 1/2 barb adapter to the intake port of the pump. Take 10" of 1/2" tube and attach it to the intake barb. This tube extends the intake port down to the lowest part of the reservoir in order to prevent the pump from running dry.

Insert the pump into the end of the bottom reservoir. Insert the 3/4" outlet barb to the outlet of the pump through the 1" hole in the top of the reservoir.



Step 19- Measure, cut and connect a length of the 3/8" tubing to the bottom of each champagne glass if you have not already done so and insert tubing into the holes in the bottom reservoir.



Step 20- Attach large size tubing going up from pump and into big hole in reservoir up top. Use an o-clamp. Test pump. You may need to attach a connector if you want to use something smaller than 1/2" tubing.



Lights

You can simply buy lighting that includes cords and sockets, or you can make your own. If you choose to buy your lights, skip to step 23.

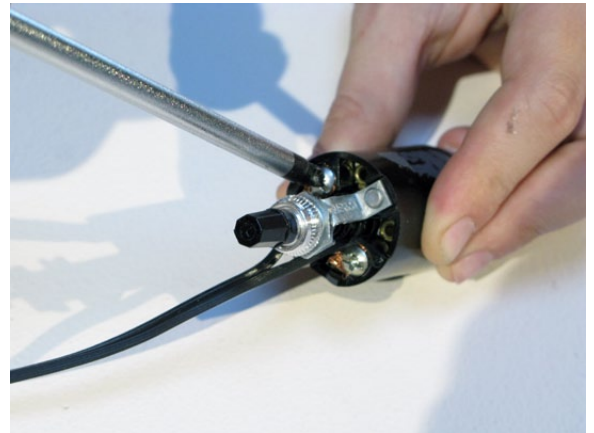
Step 21- For each light, measure/calculate length of lamp wire needed to hang light and go back to your outlet or extension cord. Cut cord.



Step 22- Attach socket and pigtail. Insert bulb.



Step 23- Hang lights close to the window glass, between plant containers so that the plant leaves are less likely to touch the bulbs.



Step 24- Plug lights into multisocket and then into timer.



Turn on Life Support Systems

Step 25- Put Plants and Hydroton clay pellets in the net cups. You can either COMPLETELY shake out roots (to prevent dirt entering system and clogging everything) of a young adult plant OR you can start your plants from seed in the compost sponges. If you start plants from seed, run water without nutrients through the system for the first week. If you start with adult plants, leave the lights off for the first few days so the plants' roots will grow better and help them recover from transplant shock.



Step 26- Fill the bottom reservoir with water and the amount of nutrient solution specified on the bottle for each gallon. Turn on the pump and time how long it takes to almost empty the bottom reservoir. Turn off the pump before the bottom reservoir is completely empty. Adjust the valves on the drip emitters so that there is a steady drip. Observe how long it takes for all the water to drip through the system. It should take more than 3 hours. If not, adjust the valves so that there is a slower drip rate.



Once you have determined pump cycle time, plug pump into timer, and set pump timer. Please note that figuring out a good drip rate for your system is a bit more art than science. You should observe and time how long it takes for the top reservoir to empty and stop dripping, and set the pump timer so that there is always a slow drip.

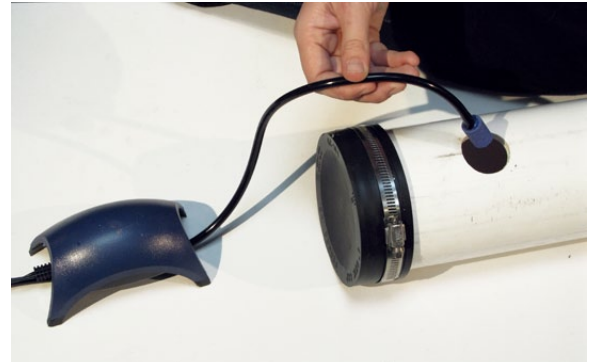
Step 27- Put plants into bottles in window.

Types of Plants

Try greens, herbs, lettuce (best when it's not so hot), cherry tomatoes, peppers, okra, strawberry. Cucumber, and large plants such as melons, zucchini and regular-sized tomatoes are not recommended. You will need to experiment a bit to see what works best in your space at what time of year. Take a look at our.windowfarms.org to see what other people have had success with.



Step 28- Put aerator (airpump with airstone) into bottom reservoir.



Maintenance

You need to change out the water and nutrients in your system once every 5-7 days. Watch your plants' performance and adjust accordingly.

Periodically, the valves at the top clog, especially soon after new nutrient solution has been added. Watch for dry spells and adjust your valves or clean them or even expand the openings with a drill as necessary. This is the most delicate part of the system. (It could use your innovations-- please share them on the Windofarms.org site!!)

As your plants mature, consider adding additional support like criss-crossing sections of fishing wire for vining plants to grow along. The plants should not touch the light bulbs, so check them periodically and adjust the bulbs or plant stems as needed. Remove dead leaves from the plants to encourage growth.

Step 29- To change nutrient solution, wait for all the water to drain into the bottom reservoir and unplug the pump from the timer so that it does not turn on while you are working. Take the endcap off the pump-free side of the bottom reservoir. Tilt the reservoir out to dump water into a bucket of some kind. Follow the directions on your nutrient solution. Adjust pH if necessary. Fill bottom reservoir with a funnel. Remember to plug your pump back in!

Step 30- Clean out your system once every two to three weeks. Use a pipe cleaner or simply blow through the tube to unclog the drip valves. Use brushes to clean pipes and tubing. Algae may accumulate in transparent parts of the system. It doesn't do much harm but it looks bad and can ultimately lead to clogging.

Share

Step 31- Sign up at our.windowfarms.org and post a short write-up and a photo of your new window farm.



7) Vendor List

Item	Link to Online Source or to a Sample Photo of the Component	Sources
Plants		Farmers markets
Water bottles		Try to find recycled sources
Net cups	http://homeharvest.com/hydroponicgrowingcontainers.htm - Order #NET3IN Premium 3-Inch Diameter Net Pot .39	Hydroponics store
Plastic martini glasses	http://images.buycostumes.com/mgen/merchandise/28026.jpg	99cent or party stores
Cuphooks	http://www.toolstation.com/images/library/stock/webbig/90559.jpg	Hardware store
Drip valves	http://www.aquariumguys.com/twowayvalve.html	Pet or aquarium store
3/8" OD - 1/4" ID tubing		Hardware store
1/4" OD tubing	http://homeharvest.com/hydroponicfittingst tubing.htm - Order #DS-MICTUB14FT, Soft Black, Vinyl, MicroTubing, 1/4 Inch, Each Foot, .25	Hardware store or hydroponics store
1/2" ID pressure tubing	1/2" ID rigid opaque tubing: Home Harvest Part number #TUB12HF at http://homeharvest.com/dripirrigationtubing.htm	Hardware store or hydroponics store
Pump	http://homeharvest.com/hydroponicpumpssubmersible.htm	Hydroponics store
Pipe for reservoirs	4" diameter pipe with 1/8" walls (lighter than the typical 1/4" walls)	Hardware store
End caps for pipe	Rubber end caps are best, with o-clamps. Ask in the plumbing section of your hardware store. 4" diameter Fernco rubber quickconnect endcaps work well.	Hardware store
Pump timer	http://homeharvest.com/hydroponictimers.htm - the second one on the page: Heavy Duty 15 Amp Grounded 24-Hour Digital Timer	Hydroponics store
Suspension cable	cable, rope, chain, or strap for suspending reservoirs, with heavy duty hooks	Hardware store
Extension cord	http://www.amazon.com/Belkin-Outlet-Office-Surge-Protector/dp/B000IF51UQ/ref=sr_1_10?ie=UTF8&s=hi&qid=1248302770&sr=1-10	Hardware store
Light sockets & plugs	Light sockets with plugs or Lamp wire, Pigtailed and Sockets - See step 21 and ask at your hardware store for the parts.	Hardware store
Light timer	http://www.amazon.com/Intermatic-TN711C-Security-Timer/dp/B000E8P7YM/ref=sr_1_3?ie=UTF8&s=hi&qid=1248303130&sr=1-3	Hardware store
Bulbs	http://www.amazon.com/n-vision-Spiral-Daylight-5M823255K/dp/B0026SIQQY	Hardware store
Tape	Duct tape or gaffer's tape	Hardware store
Bottle covers	See step 9	Hardware store / Art store
Suspension wire	Fishing wire, flexible cable (and clamps for it), rope or string	Hardware store
Cleaning brushes	Pipe cleaners, bottle brush, and a new toilet brush that will fit inside pipes for periodic cleaning	Hardware store
Cord suspenders	For hanging lighting cords from the window frame - ask at your hardware store	Hardware store
Clay pellets	http://homeharvest.com/hydroponicmediumleca.htm	Hydroponics store
Air pump and airstone	http://homeharvest.com/hydroponicpumpsaaeration.htm	Hydroponics store or Pet Supply Store
Nutrient solution	http://homeharvest.com/hydroponicnutrientorgbotanicare.htm	Hydroponics store
pH adjuster	Baking soda works to adjust pH but it is good to have the kit so you can measure the pH: Home Harvest Part #PHCONTROLKIT	

8) About

<http://windowfarms.org>
<http://our.windowfarms.org>

The Window Farms project and this document
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